10 May 2006

DEFENCE R&D DÉFENSE

Technology Maturity Levels Overview of Proposed System

Brent Hobson, NETE
Presented by David Hazen
Defence Research & Development Canada - Atlantic

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
10 MAY 2006		**00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Technology Maturity Levels Overview of Proposed System	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defence R&D Canada -Atlantic,PO Box 1012,Dartmouth, Nova Scotia B2Y 3Z7,**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002184. Presented at the Air Force Research Laboratory Seminar/Workshop on Multi-Dimensional Assessment of Technology Maturity in Fairborn, OH on 9-11 May 2006.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**16**	

Outline

- Background
- Maturity Measurement Concepts
- Technical Maturity Measurement System
- Applying the TML to Canadian Forces Projects
- Questions

Caveat

- The Technology Maturity Measurement System described in this brief is a proposal to DND sponsored by Maritime Technology Insertion Working Group. As such it does not represent approved government policy or processes.

Background

- The current Canadian Forces (CF) system/equipment acquisition process is known as the Defence Management System (DMS) and it involves a series of linear steps where information related to systems/ equipments being developed or considered for purchase is systematically passed for action between the operational, engineering and procurement groups.
- The system has five phases with go/no-go decision points as shown:
  - Identification (end of phase review and decision to proceed)
  - Options Analysis (selection of best options and decision to continue)
  - Definition (decision to purchase and to implement)
  - Procurement
  - Close-out

CF Defence Management System

IDENTIFICATION	OPTIONS ANALYSIS	DEFINITION	IMPLEMENTATION	CLOSE-OUT
Identify Capability Deficiency Capability-based Planning Validation	Formulate options Discard invalid options Assess benefits of remaining options Examine risk Decide which option should be pursued Definition Planning	Detailed review, risk assessment and costing of selected option. Implementation planning	Management/ Monitoring, i.e. Initial/Full Operational Capability Milestones Procurement/ Realty Strategies Reports on status of implementation	Full Operational Capability Operational Handover Completion Report Lessons Learned
Decision SS(ID)	Decision SS(PPA)	Decision SS(EPA)		

Background

- Currently there is no common system that allows all of these organizations to have the same clear understanding of the technical maturity level of any system/equipment at any point in the process.
- This makes assessment of technological maturity (or inversely the risk to productize such systems/equipments) very difficult and related project team discussions and decisions become equally difficult.

Maturity Measurement Concepts

- There has been a wide body of work completed in this area and a number of different systems have been developed to measure the technological maturity of military equipment/systems such as:
  - Technical Readiness Levels - ratings based on demonstrated system performance ie: laboratory proven, field proven;
  - Interface Maturity Levels – rates an equipment/system on the degree to which it is able to interact with the other equipment/ systems in the field;
  - System Readiness Levels - measures the degree documentation, training, life cycle support requirements have been completed;
  - Design Maturity Levels – establishes a series of design review targets over the life of a project; and
  - Manufacturing Readiness Levels – measures issues of concern for getting the equipment/system into commercial production.

Maturity Measurement Concepts

- Of these systems, the TRL system has found the greatest degree of acceptance and implementation in other navies. DRDC is in the process of implementing this system for use with their Technical Demonstration Program
- However, as noted by Mr. William Nolte (US Airforce Research Laboratory, Wright Patterson Air Force Base),

> "The TRL scale measures maturity along a single axis, the axis of technology capability demonstration. A full measure of technology maturity, or in the commercial world product maturity, would be a multi-dimensional metric. It's not uncommon to find references to 12 or more dimensions of product or technology maturity. One writer speaks of 16 different dimensions of maturity. The TRL measures only one of the 16" [1]

[1] Nolte, William L. Supportability & Systems Engineer, AFRL Sensors Directorate, Wright Patterson AFB, TRL Calculator, MRL Background

Technical Maturity Level System

- In an attempt to broaden the scope of technical maturity measurement for the CF, the Technical Maturity Level (TML) system has been developed at DRDC Atlantic as part of the Maritime Technology Insertion Working Group study.
- This proposed system utilizes the NATO TRL system as a baseline, but it expands each TRL level to incorporate the measurement criteria for the other systems at the equivalency levels shown in the following Table.

Table 1 - Cross System Equivalency Levels

Tech Maturity Level (TML)	Tech Readiness Levels (TRL)	Interface Maturity Levels (IML)	Design Maturity Levels (DML)	System Readiness Levels (SRL)	Manufacturing Readiness Levels (MRL)
0	0	1			
1	1	2	1		
2	2	3,4	2		
3	3	5	3	1	3
4	4	6	4	2,3	4
5	5	7	5	4,5	5
6	6	8	6	6	6
7	7	9	7	7	7
8	8		8	8	8
9	9		9	9	9
TML	T-TRL	P-PROGRAMMATICS			M - MANUFACTURING

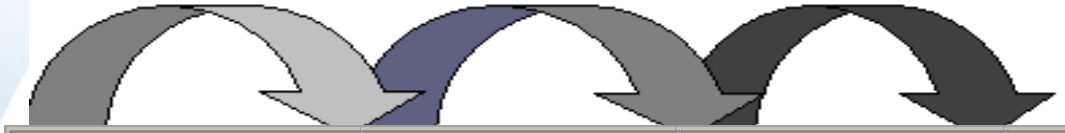
Technical Maturity Level System

- In developing the TML scale, it was decided that each each level would be comprised of criteria from three sub-areas:
  - Technical Readiness.
  - Programmatics – this sub-area combines the measurement criteria for Interface, Design, and System issues
  - Manufacturing Readiness.
- The criteria in each of the sub-areas must be met before making a TM Level determination for any system/equipment
- An extract of the resulting Technology Maturity Level (TML) scale is shown in Table 2 and the following slide shows the use of the TML system in the CF Defence Management process.

Table 2 – TML Scale Extract

TM Level	Description T–Technical Readiness, P – Programmatics, M – Manufacturing Readiness
4	**T - <u>Component & / or "Breadboard" Validation in Laboratory/Field Environment</u> - Basic technology components are integrated. This is relatively "low fidelity" compared to the eventual system. Examples of R&D results include integration and testing of "ad hoc" hardware in a laboratory/field setting. Often the last stage for R&D (funded) activity.** **P – Interfaces partially demonstrated - system/sub-system level in a high fidelity synthetic environment** **- Critical design review completed for critical sub-systems** **- Preliminary Safety/Environmental assessments complete** **- Supportability work breakdown structure completed** **- Sub-system R&M case developed for sub-systems.** **- Initial Human Machine Interface design completed** **- Key Sub-System schematics completed.** **- All Sub-System Specifications defined** **- Engineering and operational communities negotiated a formal commitment to use the results of the research.** **M – Laboratory Manufacturing Process demonstrated**

DMS Phases Showing TML Match-up



IDENTIFICA-TION	OPTIONS ANALYSIS	DEFINITION	IMPLEMENTA-TION	CLOSE-OUT
Identify Capability Deficiency Capability-based Planning Validation	Formulate options Discard invalid options Assess benefits of remaining options Examine risk Decide which option should be pursued Definition Planning	Detailed review, risk assessment and costing of selected option. Implementation planning	Management/ Monitoring, i.e. Initial/Full Operational Capability Milestones Procurement/ Realty Strategies Reports on status of implementation	Full Operational Capability Operational Handover Completion Report Lessons Learned
TML 1,2	*TML 4*	*TML 6*	*TML 8*	*TML 9*

Decision SS(ID) *TML 3*	Decision SS(PPA) *TML 5*	Decision SS(EPA) *TML 7*

Conclusions

- The CF currently has no system to measure and report technology maturity levels between the various NDHQ groups who collectively progress the development, procurement and acquisition of systems and equipment.
- Canada's major defence allies (US, UK) are developing and implementing a number of different systems to provide this common traceability for their acquisitions.
- A combined system such as the TML would be a good starting point for the CF to add such a capability into the development and acquisition aspects of systems being progressed through the DMS.

Selected References

- OSD Technology Readiness Assessment (TRA) Deskbook. http://www.defenselink.mil/ddre/doc/tra_deskbook.pdf
- NATO TRLs http://www.saclantc.nato.int/trl.html
- UK MOD Acquisition Management System http://www.ams.mod.uk/ams/default.htm
- UK Production Maturity Levels: http://www.ams.mod.uk/ams/content/docs/prodmaty.htm
- CA DND Defence Planning and Management http://www.vcds.forces.gc.ca/dgsp/pubs/dp_m/intro_e.asp
- Brent Hobson, “A Technology Maturity Measurement System for the Department of National Defence”. DRDC Atlantic CR 2005-279. (available soon)

Questions?